

University of New Orleans

ScholarWorks@UNO

Department of Economics and Finance Working
Papers, 1991-2006

Department of Economics and Finance

2005

Managerial Career Concerns and Risk Management

Jouahn Nam
Pace University

Jun Wang
Baruch College

Ge Zhang
University of New Orleans

Follow this and additional works at: https://scholarworks.uno.edu/econ_wp

Recommended Citation

Nam, Jouahn; Wang, Jun; and Zhang, Ge, "Managerial Career Concerns and Risk Management" (2005).
Department of Economics and Finance Working Papers, 1991-2006. Paper 42.
https://scholarworks.uno.edu/econ_wp/42

This Working Paper is brought to you for free and open access by the Department of Economics and Finance at ScholarWorks@UNO. It has been accepted for inclusion in Department of Economics and Finance Working Papers, 1991-2006 by an authorized administrator of ScholarWorks@UNO. For more information, please contact scholarworks@uno.edu.

Managerial Career Concerns and Risk Management

Jouahn Nam, Jun Wang and Ge Zhang*

Abstract

We present a dynamic model of corporate risk management and managerial career concerns. We show that managers with high (low) career concerns are more likely to speculate (hedge) early in their careers. In the later stage of their careers when managers have less career concerns, there is no speculative motive for self interested managers. On the other hand, managers with minimal career concerns engage in neither hedging nor speculation early in their careers, but they may choose to hedge after poor early performance.

*Nam is from Lubin School of Business, Pace University, New York, NY, 10038. phone: (212) 346-1818, email: jnam@pace.edu. Wang is from LSU and Baruch College, Department of Finance, Baton Rouge, LA 70803 phone: (225) 578-6335, fax: (225) 578-6366, email: junwang@lsu.edu. Zhang is from Department of Economics and Finance, College of Business Administration, University of New Orleans, New Orleans, LA 70148. Tel: (504) 280-6096, email: gzhang@uno.edu. We would like to thank Gerald Gay, Tom Noe, Michael Rebello, Rubin Saposnik for many helpful comments. All errors are ours.

1 Introduction

In a world with no friction such as the world in Modigliani and Miller (1958), one can use an argument similar to the one concerning financing activities to show that risk management does not change the value of the firm. Different financing activities only change the distribution of firm value among various claim holders but do not affect the total value of the firm. Since shareholders of the firm can achieve their goal of reducing systematic risk by holding a diversified portfolio, corporate risk management neither increases nor decreases shareholders' welfare. If risk management bears a cost, it is a strictly value-reducing activity. Therefore, the classical paradigm suggests that corporate managers should not engage in any risk management activities at all.

The increasing use of derivatives by corporations contradicts this prediction suggested by the classical paradigm. To find the reasons behind this increasing demand for risk management products, economists have introduced several types of friction in order to model the world in a more realistic way. The rationales for corporate risk management fall into two main paradigms: shareholder wealth maximization and manager utility maximization. Three theories of hedging have been advanced that are based on the shareholder wealth maximization paradigm – the reduction in expected taxes theory, the reduction in the costs of financial distress theory and the mitigation of the underinvestment problem theory.¹ Empirical tests of these theories have produced mixed results, but two theories – reduction in the costs of financial distress theory and mitigation of the underinvestment problem theory – have received substantial support.² Following the theory of manager wealth maximization, a manager has an incentive to induce the firm to hedge more or less in order to maximize their own wealth.³ Several empiri-

¹See Mayers and Smith (1982); Smith and Stulz (1985); Smith, Smithson, and Wilford (1990); and, Froot, Scharfstein and Stein (1993).

²See Wall and Pringle (1988); Nance, Smith, and Smithson (1993); Dolde (1995); Allayannis and Ofek (2001); Berkman and Bradbury (1996); Mian (1996); Tufano (1996); Geczy, Minton, and Schrand (1997); Gay and Nam (1998); and, Howton and Perfect (1998)

³See Smith and Stulz (1985), Breeden and Viswanathan (1998), and DeMarzo and Duffie (1995).

cal studies, such as Tufano (1996), Gay and Nam (1998), Knopf, Nam, and Thornton (2002), provide the supporting evidence.

While these studies have increased our understanding as to why or what motivates corporations to manage risk, less attention has been directed to managerial career concerns as a major determinant of firms risk management. DeMarzo and Duffie (1995) and Breeden and Viswanathan (1998) explore this connection between risk management and manager career concern (or, compensation) using models in which shareholders learn about the quality of a firms management by observing the firms operating performance. In these models managers enhance the learning process by hedging those macroeconomic-related risks that are considered outside their control. Risk management, therefore, reduces the noise contained in earnings and thus increases their usefulness as indicators of managerial quality. Following this line of reasoning, we provide a model for the self-interested manager, who is concerned about his or her own career and compensation.

We here provide a dynamic model with two time periods, so that the time series properties of corporate risk management activities can be derived. In our model, there exist good managers and bad managers. The manager's true ability is his or her own private information, and the compensation contract is a short-term contract revised by the shareholders to reflect the reputation of the manager at the time of revision. In this model, the firm also faces a takeover threat by a corporate raider who is taking over firms with bad managers. Without knowing the true type of the manager, the raider makes the takeover decision based on perceived managerial reputation. Once the firm is taken over, the manager loses his or her job, future wage income, and firm specific rent. In each period, there is a cash flow signal, which the manager can manipulate through hedging or speculation. The action of hedging or speculation is a private action conducted by the manager, not observable to the others, but rationally anticipated by the shareholders and the corporate raider. If the raider takes over a firm after certain cash flow realization, the manager will have the incentive for hedging or speculation to reduce the probability of generating such cash flow.

We contribute to the literature of corporate risk management by studying how managerial career concerns at different career stages affect the activities of hedging and speculation. We show that managers with some career concerns are likely to hedge early in their careers. Later in their careers, their hedging activities decrease. This result is consistent with the empirical evidence provided by Tufano (1996).

Our model also provide several new empirical predictions and most of them have not been tested before. Because managers with high career concerns must produce really good results to convince shareholders and outsiders of their quality, they are likely to speculate early in their careers. Over time, since bad managers are more likely to lose their jobs, the pool of surviving managers consists of more good managers. Managers have less career concerns, and the speculative motive disappears.

The previous two results apply to managers who have some career concerns. However, we show that managers with minimal career concerns engage in neither hedging nor speculation early in their careers. These managers may only choose to hedge after poor early performance. For these managers, the only time we may observe some hedging activities is after the firm's early results are bad.

Note that because we consider a dynamic two-period model, we can illustrate an explicit time series pattern of hedging and speculation activities over managerial tenure. This feature allow us to make richer predictions of corporate risk management than those single period models. The other unique feature in our model is that we allow for speculation as one possible strategy while most of the existing models (such as DeMarzo and Duffie (1995), Breeden and Viswanathan (1998)) do not. When the manager prefers a spread-out cash flow distribution, he or she can speculate in our model but can only choose not to hedge in theirs. Hence our model can provide predictions on when managers may prefer to hedge and when they may prefer to speculate. Knowing when managers may want to speculate can be useful to shareholders and boards to either increase monitoring or design compensation mechanism to reduce the incentive to speculate.

This paper is organized as follows. We describe the framework and equilibrium in Section 2. In Section 3, we analyze various equilibria. Section 4 discusses our results and Section 5 concludes.

2 Model Setup

2.1 The Framework

We consider a two-period model with zero interest rate. All parties in the game are risk neutral. The firm is managed by a manager. There are two types of managers in the world, good managers (G) and bad managers (B). The manager knows his or her own type, but the shareholders and the outsiders do not know the exact type of the manager. At the beginning of the first period, they know that there is a probability of μ that the manager is a good manager. In each period, the firm generates a cash flow. The cash flow in period k , Y_k , takes one of the three values, 0, 1, and 2. This cash flow is publicly observable. The probability distribution of this cash flow signal Y_k depends on the true ability of the manager and the risk management action that the manager takes in this period. If the manager is good and does not take any risk management action, the probability distribution of Y_k taking value from states 0, 1, 2 is represented by $P^N = (1 - \alpha - \beta, \beta, \alpha)$, ($0 < \alpha, \beta < 1$). Thus, given a good manager who does no hedge or speculate, the expected value of Y_k is $2\alpha + \beta$. If the manager is bad and does not actively manage financial risks, the probability distribution of Y_k is given by $Q^N = (\alpha, \beta, 1 - \alpha - \beta)$. The expected value of Y_k under a bad manager is $2 - 2\alpha - \beta$.

In each period, the manager can hedge or speculate to alter the probability distribution of the cash flow Y_k . We refer risk management to both hedging and speculation. In keeping with most models on corporate hedging, risk management is modeled as an action that changes the variance of the cash flow distribution while preserving the mean of the cash flow. Hedging reduces the variance of the cash flow while speculation increases the variance. Furthermore,

the operational details of such activities are abstracted and it is assumed that the cash flow Y_k follows a new probability distribution with the same mean and smaller (larger) variance when the manager hedges (speculates). In particular, if the manager is good, the distribution of Y_k is given by $P^H = (1 - \alpha - \beta - \delta, \beta + 2\delta, \alpha - \delta)$, ($\delta > 0$), if he or she hedges and $P^S = (1 - \alpha - \beta + \delta, \beta - 2\delta, \alpha + \delta)$ if he or she speculates. It can be easily verified that the expected value of Y_k remains the same, and the variance of Y_k decreases after hedging and increases after speculation. Similarly, if the manager is bad, the distribution of Y_k is given by $Q^H = (\alpha - \delta, \beta + 2\delta, 1 - \alpha - \beta - \delta)$ if he or she hedges and $Q^S = (\alpha + \delta, \beta - 2\delta, 1 - \alpha - \beta + \delta)$ if he or she speculates. We make the following assumptions on α , β , and δ to ensure that a higher cash flow always indicates a higher probability of a good manager than a lower cash flow.

$$\alpha + \beta + \delta < 1 \quad (1)$$

$$2\beta + \alpha > 1 + 2\delta \quad (2)$$

$$\alpha - \beta > 2\delta. \quad (3)$$

Condition (1) ensures that the cash flow will fall into any one of three states with non-zero probability no matter what action the manager takes. Conditions (2) and (3) allow the good manager to always have larger probability to generate high cash flow: $P(Y_k = 2) > P(Y_k = 1) > P(Y_k = 0)$. The opposite is true for the bad manager: $Q(Y_k = 2) < Q(Y_k = 1) < Q(Y_k = 0)$. Let $P^i(m)$ ($Q^j(m)$) represent the probability of the good (bad) manager generating cash flow m using strategy $i(j)$ where $i(j)$ may be hedging (H), speculation (S), or no action (N). By making the above assumptions, the monotone likelihood ratio property (see Milgrom, 1981) is satisfied for the probability distributions of cash flows. That is, no matter what risk management activity each type of manager takes, the probability ratio, $P(Y_k)/Q(Y_k)$, increases with the cash flow Y_k :

$$\frac{P^i(0)}{Q^j(0)} \leq \frac{P^i(1)}{Q^j(1)} \leq \frac{P^i(2)}{Q^j(2)}, \quad (i, j) \in \{(N, H, S) \times (N, H, S)\} \quad (4)$$

Given this setup, the manager can achieve the purpose of hedging or speculation by having the appropriate probability distribution of cash flow. The specific action that the manager

needs to take to induce such a distribution is not modeled here, but with the plethora of new financial markets, derivative products, and other financial innovations, the manager can achieve a wide range of value-neutral risk shifts through financial contracting. By modeling the risk management action at the level of its outcome, namely the distribution of cash flow, the key insight of risk management – value neutral shifts of risk – is captured while the operational details are abstracted.

There exists a fixed cost for doing risk management, c . This cost, similar to a transaction cost, may include brokerage fees and commissions that the manager has to pay to enter into financial contracts. It may also be the opportunity cost that the manager incurs when he or she devotes time and energy to understanding financial markets and finding the right combination of financial instruments in order to achieve the desired risk profile. This cost is not the price that the manager pays for the financial contracts. Because the expected value of firm cash flow stays the same after risk management, the price for these financial contracts should be zero in a risk-neutral and frictionless world. Therefore, this fixed cost for hedging and speculating should be considered as a form of transaction cost.

As first shown by Holmstrom and Ricart i Costa (1986), when a long-term contract between the manager and the owner/shareholders is not feasible, the manager and the owner negotiate the managers compensation contract in each period so that the manager is paid based on his or her reputation at the time of contracting. In particular, it is assumed that the manager is paid three times in this game for his or her service: at the beginning of the first period (W_0), at the beginning of the second period (W_1), and at the end of the game (W_2). The first two payments are the wages for the two periods. The last payment can be considered as a bonus or the future wage that the manager could have earned had there been one more period. The shareholders can observe the cash flows in the two periods but not the risk management actions. They infer the reputation of the manager from the cash flow generated by the firm

in each period and make their conjectures about risk management activities. The payment follows the formula

$$W_k = \gamma \text{Prob}(\text{manager is good} | \mathbf{I}_k) \quad (5)$$

where γ is a coefficient that maps managerial reputation to compensation, and \mathbf{I}_k is the information set of the shareholders at time k . If the wages of bad managers are normalized to zero and the marginal productivity of good managers are assumed to be γ , then the optimal wage that the owner is willing to pay a manager is γ multiplied by the managerial reputation as long as the managerial labor market is competitive.

Note that Y_1 and Y_2 represent the firm cash flow in the first period and the second period. The information set at time 0 is simply the prior probability of a good manager, μ . The information set at time 1 contains the prior probability, the first period cash flow, and the conjecture on the risk management action the manager takes in the first period. The information set at time 2 contains the information set at time 1, the second period cash flow, and the conjecture on the risk management action in the second period. Specifically,

$$\begin{aligned} \mathbf{I}_0 &= [0, 1] \\ \mathbf{I}_1 &= \mathbf{I}_0 \times \{0, 1, 2\} \times \Theta \\ \mathbf{I}_2 &= \mathbf{I}_1 \times \{0, 1, 2\} \times \Theta \times \Theta \times \Theta \end{aligned} \quad (6)$$

where $\Theta = \{N, H, S\} \times \{N, H, S\}$ is the risk management action set available to two types of managers. Notice that \mathbf{I}_2 contains the cross product of three Θ sets which correspond to the risk management action that the manager can take in the second period when the first period cash flow Y_1 is 0, 1, and 2.

There is a corporate raider who also observes the firm cash flows and decides whether to take over the firm at the end of each period. The raider has an alternative manager whose ability ξ is known to the raider. Assuming there is no hold-out problem, the raider can take over the firm by paying the shareholders the firm value under the current manager. Since good managers generate higher values to the owner, the raider will take over the firm if and only

if the reputation, i.e. the probability of being good, of the current manager is less than the reputation of the alternative manager, ξ . After takeover, the raider fires the old manager and employs the alternative manager. In addition, it is assumed that there is a limited number of projects available so that the manager, who loses his or her job from takeover, does not find another job and receives no future income. In other words, if the firm is taken over at the end of the first period, the manager loses two payments, W_1 and W_2 . If the firm is taken over at the end of the second period, the manager loses the final payment W_2 . This is consistent with the empirical evidence of Agrawal and Walkling (1994), who show that target firm managers are more likely to lose their jobs after takeover and generally remain jobless for the following three years. The information sets of the corporate raider are the same as those of the shareholders. Figure 1 is an illustration of the time line of this game.

2.2 Equilibrium

The equilibrium concept used is Perfect Bayesian Equilibrium (see e.g. Fudenberg and Tirole, 1991). The shareholders and the corporate raider conjecture the risk management activities of the manager and update the probability of a good manager based on Bayes rule. The payments to the manager depend on this revised probability, as do the takeover activities. On the equilibrium path, the conjecture on the risk management action of the manager is consistent with the actual strategy the manager is playing. The manager chooses his or her optimal risk management strategy based on the equilibrium strategies of the shareholders and the corporate raider.

Clearly, the probability of a good manager at information set \mathbf{I}_0 is the prior probability μ . If the period 1 cash flow Y_1 is m , $m \in \{0, 1, 2\}$ and the conjectured risk management action $a_1(b_1)$ that a good (bad) type of manager takes is $i(j)$, where i and j belong to $\Theta = \{N, H, S\}$,

the probability of a good manager at time 1 given cash flow m , $\pi_1(m)$, can be computed from the Bayes rule,

$$\pi_1(a_1 = i, b_1 = j, Y_1 = m) = \frac{\mu P^i(m)}{\mu P^i(m) + (1 - \mu) Q^j(m)}. \quad (7)$$

In the same way, the probability of a good manager at the end of period 2, π_2 , is determined from period 1 cash flow, period 2 cash flow, and the conjectured risk management action in the second period for the particular Y_1 . In the second period, the prior is $\pi_1(m)$ and the risk management action can be different for different realizations of period 1 cash flow. Let $\pi_2(i, j, m, i', j', m')$ be the posterior probability of a good manager given that the first period cash flow $Y_1 = m$, conjectured first period risk management action $a_1 = i, b_1 = j$, second period cash flow $Y_2 = m'$, and conjectured second period risk management action $a_2(m) = i', b_2(m) = j'$.

$$\pi_2(i, j, m, i', j', m') = \frac{\pi_1(i, j, m) P^{i'}(m')}{\pi_1(i, j, m) P^{i'}(m') + (1 - \pi_1(i, j, m)) Q^{j'}(m')}. \quad (8)$$

Note that the posterior probability is a monotone increasing function of the probability ratio ($P(m)/Q(m)$). This ratio is always assumed to be bigger if the realized cash flow is higher, regardless of the risk management activities. In this way, the higher realization always contains more positive information which is consistent with the common sense of the financial industry. This assumption also allows for exclusion of those non-intuitive equilibria where higher cash flow is considered a signal of bad management and where the manager is punished for generating a high cash flow.

The corporate raider makes a takeover attempt only if the reputation of the manager is lower than that of the alternative manager. Since the raider has the same information as the shareholders, the managers reputation is π and takeover occurs if $\pi < \xi$.

The managers total payoff is the sum of W_0 , W_1 , and W_2 . Because of the possible takeover, the manager does not always receive all three payments. The payment at time 0, W_0 , is determined solely by prior probability and does not change with the risk management action the manager takes; therefore, it will no longer be included in the managers payoff function. The strategy space of the manager is $\Omega = \Theta \times \Theta \times \Theta \times \Theta$, where the first $\Theta = \{N, H, S\}$ is the

action choice set in the first period and the next three are the second period strategy sets corresponding to the three realizations of the first period cash flow. Furthermore, the belief of the shareholders and the raider are simplified as $(\pi_1(a_1, b_1), \pi_2(a_2(0), b_2(0)), \pi_2(a_2(1), b_2(1)), \pi_2(a_2(2), b_2(2)))$ where $\pi_1(a_1, b_1)$ is the probability distribution of a good manager at time 1, given that a good manager takes risk management action a_1 and a bad manager takes action b_1 . $\pi_2(a_2(m), b_2(m))$, $m \in \{0, 1, 2\}$, represents the probability distribution of a good manager when the managers of the two types take first period actions a_1 and b_1 , the first period cash flow Y_1 is m , and the managers take second period actions $a_2(m)$ and $b_2(m)$. Let

$$\pi_2(a_2(m), b_2(m)) = \{\pi_2(a_2(m), b_2(m), 0), \pi_2(a_2(m), b_2(m), 1), \pi_2(a_2(m), b_2(m), 2)\}, \quad (9)$$

where $\pi_2(a_2(m), b_2(m), l)$ is the posterior probability of the manager being good given second period cash flow l . Hence, given such a belief of the shareholders, the expected payoff of a good manager at the time when he or she takes risk management action $s_2(m)$ in the second period is

$$U_2^G(m, s_2(m)) = \sum_{l=0}^2 P^{s_2(m)}(l) \gamma \pi_2(a_2(m), b_2(m), l) I(\pi_2(a_2(m), b_2(m), l) \geq \xi) - cI(s_2(m) \neq N) \quad (10)$$

where $I(\cdot)$ is the indicator function which equals 1 if the condition in the parenthesis is true and 0 if false. The intuition for this payoff is straightforward. $\gamma \pi_2(a_2(m), b_2(m), l)$ is the payment at time 2 and $P^{s_2(m)}(l)$ is the probability of arriving at state l given the risk management strategy $s_2(m)$. The manager does not receive this payment if the conjectured probability of a good manager at this state does not exceed the takeover hurdle, in which case the firm is taken over by the raider. The last term is the cost of risk management which is not incurred if the strategy is no action.

With the expected payoff of period 2 computed for all possible realizations of Y_1 , we can determine the total expected payoff of a good manager who chooses period 1 risk management action s_1 and period 2 action $\mathbf{s}_2 = (s_2(0), s_2(1), s_2(2))$,

$$U_1^G(s_1, \mathbf{s}_2) = \sum_{l=0}^2 P^{s_1}(l) [\gamma \pi_1(a_1, b_1, l) + U_2^G(l, s_2(l))] I(\pi_1(a_1, b_1, l) \geq \xi) - cI(s_1 \neq N) \quad (11)$$

Note that when the time 1 probability of a good manager is smaller than the takeover hurdle ξ , the firm is taken over by the raider at time 1, and the manager loses both time 1 payment W_1 and future payoff $U_2^G(l, s_2(l))$.

In the same way, the payoff of a bad manager in the second period is denoted as $U_2^B(m, s_2(m))$ and the total payoff of a bad manager as $U_1^B(s_1, \mathbf{s}_2)$, in particular,

$$U_2^B(m, s_2(m)) = \sum_{l=0}^2 Q^{s_2(m)}(l) \gamma \pi_2(a_2(m), b_2(m), l) I(\pi_2(a_2(m), b_2(m), l) \geq \xi) - cI(s_2(m) \neq N) \quad (12)$$

$$U_1^B(s_1, \mathbf{s}_2) = \sum_{l=0}^2 Q^{s_1}(l) [\gamma \pi_1(a_1, b_1, l) + U_2^B(l, s_2(l))] I(\pi_1(a_1, b_1, l) \geq \xi) - cI(s_1 \neq N) \quad (13)$$

Definition of Equilibrium: The following strategies and beliefs form a Perfect Bayesian Equilibrium in this game:

- The belief of the shareholders and the corporate raider is that the good manager takes risk management action a_1 in the first period and $\mathbf{a}_2 = (a_2(0), a_2(1), a_2(2))$ in the second period corresponding to different Y_1 . The bad manager takes risk management action b_1 in the first period and $\mathbf{b}_2 = (b_2(0), b_2(1), b_2(2))$ in the second period corresponding to different Y_1 .
- The strategy of the shareholders is to pay the manager $\gamma \pi_1(a_1, b_1, m)$ at time 1 if the firm has not been taken over and if Y_1 equals m . At time 2, the manager is paid $\gamma \pi_2(a_1, b_1, m, a_2(m), b_2(m), m')$ if the firm has not been taken over and if Y_1 equals m and Y_2 equals m' . The strategy of the raider is to take over the firm whenever π is less than ξ and to do nothing otherwise.
- The strategy of the good manager is (s_1^G, \mathbf{s}_2^G) which generates the maximum payoff, given the strategies of the shareholders and the raider. The strategy of the bad manager is (s_1^B, \mathbf{s}_2^B) which generates the maximum payoff for the bad manager. In particular,

$$U_1^G(s_1^G, \mathbf{s}_2^G) = \max_{(s_1, \mathbf{s}_2) \in \Omega} U_1^G(s_1, \mathbf{s}_2) \quad (14)$$

$$U_2^G(m, s_2^G(m)) = \max_{s_2 \in \{N, H, S\}} U_2^G(m, s_2), \quad m \in \{0, 1, 2\} \quad (15)$$

$$U_1^B(s_1^B, \mathbf{s}_2^B) = \max_{(s_1, \mathbf{s}_2) \in \Omega} U_1^B(s_1, \mathbf{s}_2) \quad (16)$$

$$U_2^B(m, s_2^B(m)) = \max_{s_2 \in \{N, H, S\}} U_2^B(m, s_2), \quad m \in \{0, 1, 2\} \quad (17)$$

- The strategies chosen by the managers are consistent with the belief of the shareholders and the corporate raider, i.e. $s_1^G = a_1$, $s_1^B = b_1$, $s_2^G(m) = a_2(m)$, and $s_2^B(m) = b_2(m)$ for all $m \in \{0, 1, 2\}$ such that $\pi_1(a_1, b_1, m) \geq \xi$.

3 Analysis

This game is fairly complicated and the main goal is to show that there exist equilibria such that the manager may hedge or speculate early in his or her tenure while choosing no action late in his or her tenure. To illustrate the existence of such equilibrium, we choose a base set of parameters as $\alpha = 0.55$, $\beta = 0.35$, $\delta = 0.05$, $\xi = 0.5$, $\gamma = 10$.⁴ Based on these parameter values, the expected cash flow by a good manager is 1.45, and the expected cash flow by a bad manager is 0.55. In this paper, the focus is on risk management activities such as buying and selling futures or forwards, which have the characteristics of simultaneously reducing or increasing the probability weights at both tails of distribution. The other commonly used risk management vehicles are options, which usually affect one tail of the distribution while changing the skewness of the distribution to preserve the mean. Options are not considered here because the three-state distribution is not rich enough to model options in a meaningful way and because the insight that can be drawn from futures/forwards contracts can also be applicable to the usage of options.

First we investigate the effects of the prior probability of a good manager and the cost of doing risk management on risk management choices. The prior probability of a good manager

⁴Our results are robust with variation of these parameters. We get the same results with other parameter values.

is the initial reputation of the manager, and the posterior probability is the revised reputation of the manager after he or she manages the firm for some time and the firm performance under his or her management is available.

Two cases are of less interest. One is when the cost of risk management is so high that it is never optimal to engage in any risk management activities. Since the gain to the manager comes from the change of the cash flow distribution and the change of expected payoff, this gain can be less than the cost if the cost is sufficiently high. The other case occurs when the initial reputation of the manager is so low that the raider always takes over the firm at time 1 regardless of the cash flow signal since the revised reputation is low enough to justify such a takeover. In these two cases, the risk management activities have no effect on the outcome of the game. In this model, we direct our focus toward the case where risk management activities do make a difference. In other word, risk management cost is not too high and the initial reputation of the manager is not too low.

We identify an equilibrium for a specific set of parameter values by the following steps. First we conjecture a set of strategies for managers of two types. Then we verify that this set of strategies are indeed optimal for managers if shareholders and raiders believe the same. If we can show optimality for managers, then we find an equilibrium. Otherwise, this equilibrium does not exist for this set of parameter values. By varying the initial reputation of the manager (μ) and the cost of risk management (c), we are able to identify different equilibria for different parameters.

3.1 High managerial career concerns

The first result is that for a certain range of managerial reputation, there exist equilibria that both types of managers choose speculation in the first period and the raider takes over the firm at time 1 if the cash flow realization is 0 or 1. Hence managers have very high career concerns in this case because of the high takeover threat. If the period 1 cash flow is 2, the two types of

managers may choose hedging, or no action in the second period depending on the cost and the reputation.

Result 1: There exist equilibria with the following characteristics:

- The shareholders and the raider believe that both types of managers speculate in the first period. If the period 1 cash flow is 2, both types of managers may hedge or take no risk management action in the second period depending on the parameterization.
- The raider takes over the firm if period 1 cash flow Y_1 is less than 2 at time 1. If $Y_1 = 2$, the raider does not attempt a takeover at time 1 and makes the period 2 takeover decision based on the new reputation. The shareholders pay the manager $\pi_1(S, S, 2)$ at time 1 if $Y_1 = 2$ and accordingly at time 2.
- Both types of managers speculate in the first period. In the second period, the manager of either type may hedge or choose no action depending on the parameterization.

Figure 2 illustrates the region of reputation and cost combination where two such equilibria exist. Equilibrium I and Equilibrium II, share two common characteristics: both types of managers speculate in the first period, and the raider takes over the firm if period 1 cash flow Y_1 is not 2, the highest possible realization. The main difference between these equilibria is the actions taken in the second period. In Equilibrium I, both types of managers hedge in the second period, while both do not take any action in Equilibrium II.

Both equilibria exist when initial reputation of the manager is not very high, (less than 0.5 in Figure 2). The firm being taken over in the first period is the most costly to managers. After early takeover, managers lose income in both periods. Thus they would do whatever to reduce the probability of an early takeover. When the initial reputation is not very high, the raider will take over the firm unless there is superior performance. In this case, managers have high career concerns, and these concerns drives managers of both types to speculate in order to boost the probability of superior performance. Hence both types of managers speculate in a large range of parameter values.

The cost of hedging and speculation has a stronger effect on managerial action in the second period. As shown in Figure 2, when the cost is close to zero, both types of managers engage in hedging activity in the second period. This preference of active risk management to passive risk management is not surprising at low transaction costs. The payoff of the manager in the second period is

$$U_2(s_2) = \sum_{l=0}^2 \text{Prob}^{s_2}(l) \gamma \pi_2(a_2, b_2, l) I(\pi_2(a_2, b_2, l) \geq \xi) - cI(s_2 \neq N) \quad (18)$$

When c is close to zero, the payoff is the expected payment minus takeover loss at time 2. If the net effect of the shareholders payment and the raiders takeover threat is that cash flows at the center of the distribution are preferred to cash flows in both tails of the distribution, the manager has an incentive to hedge. Otherwise, the incentive for speculation is high. As no action generates a distribution that is between the distributions generated by hedging and by speculation, with risk management cost almost zero, the strategy of no action can only be optimal in very special cases. This is why the exclusion of speculation by Breeden and Viswanathan (1998) may impose a large bias on their results.

When the transaction cost of no action is greater than zero, the passive strategy of no action can become optimal in the second period. In Equilibrium II, both types prefer the no-action strategy. Note that the time series pattern of managerial risk management behavior of this equilibrium is that managers speculate early in their career and take no action later. The intuition is that taking action in the first period affects the total payoff of the manager more than the action in the second period. In this equilibrium, if the first period cash flow is not 2, the manager loses both W_1 and W_2 . If there is a takeover in the second period, the manager only loses W_2 . Hence, the gain from avoiding takeover in the first period is higher than the gain from avoiding takeover in the second period. If the transaction cost of hedging or speculation is greater than the gain in the second period but less than the gain in the first period, there exist equilibria where the managers speculate in the first period but take no action in the second period. The fact that the manager loses all future payoff if he or her does not build an early reputation to avoid takeover is the key to the existence of such equilibria. In these equilibria,

if one investigates the relation between risk management activities and managerial tenure, one would find that new managers are more likely to speculate than old managers.

3.2 Medium managerial career concerns

When the initial managerial reputation increases, the raider may not want to take over the firm if the first period cash flow is medium. The raider may still be able justify a takeover when the first period cash flow is low. In this case, managers still have some career concerns, and both the good manager and the bad manager have incentive to hedge in order to reduce the probability of ending up with low first period cash flow. Our next result shows that there exist such equilibria.

Result 2: There exist equilibria with the following characteristics:

- The shareholders and the raider believe that both types of managers hedge in the first period. If the period 1 cash flow is 1 or 2, both types of managers may hedge or take no risk management action in the second period depending on the parameterization.
- The raider takes over the firm if period 1 cash flow Y_1 is 0 at time 1. If Y_1 is 1 or 2, the raider does not attempt a takeover at time 1 and makes the period 2 takeover decision based on the new reputation. The shareholders pay the manager $\pi_1(S, S, i)$ at time 1 if $Y_1 = i, i \in \{1, 2\}$ and accordingly at time 2.
- Both types of managers hedge in the first period. In the second period, the manager of either type may hedge or choose no action depending on the parameterization.

Figure 2 illustrates the region of reputation and cost combination where two such equilibria, Equilibrium III and Equilibrium IV, exist. In these two equilibria, managers have higher initial reputation and lower career concerns than managers in Equilibria I and II. Hence, both types of managers hedge the first period, and the raider takes over the firm if period 1 cash flow Y_1 is 0, the lowest possible realization. The main difference between these equilibria is

the actions taken in the second period. In Equilibrium III, both types of managers hedge in the second period after all cash flow realizations. In Equilibrium IV, no manager takes any action in the second period. The key factor that differentiates Equilibrium III and Equilibrium IV is again the cost of hedging and speculation. With this cost extremely low, managers engage in hedging activities all the time. With moderately high cost, managers may choose no action in the second period.

Note that in Equilibrium IV, the managers are observed to be engaged in hedging activities in the first period but not in the second period. Tufano (1996) documents such a negative correlation between hedging activities and managerial tenure in the gold mining industry. Our results support Tufano's (1996) empirical finding.

3.3 Minimal managerial career concerns

If the initial reputation of the manager is really high, the raider may not mount a takeover attempt for any period 1 cash flow realization. Instead, the raider may need two consecutive bad cash flows to justify a takeover. In other words, managers have minimal career concerns. If this is the case, the manager becomes particularly concerned when the first period cash flow is the worst and consequently have a strong incentive to hedge in the second period if $Y_1 = 0$. Indeed, such an equilibrium exists.

Result 3: There exists an equilibrium with the following characteristics:

- The shareholders and the raider believe that both types of managers take no action in the first period. If the period 1 cash flow is 1 or 2, both types of managers take no action again in the second period. If the period 1 cash flow is 0, both types of managers hedge in the second period.
- The raider does not take over the firm at time 1. At time 2, the raider takes over the firm when both cash flow realizations are 0 and does not take over in other states. The

shareholders pay the manager $\pi_1(N, N, 0)$ or $\pi_1(N, N, 2)$ at time 1 if Y_1 equals 1 or 2 and accordingly at time 2.

- Both types of managers adopt the passive strategy of no action in the first period. In the second period, both types hedge in the second period if $Y_1=0$ and take no action in other states.

Figure 3 shows the existence of such an equilibrium (Equilibrium V) for combinations of risk management cost and initial reputation. Note that the initial reputation for such an equilibrium to exist is quite high: the prior probability of a good manager is over 0.95. Managers in this case have minimal career concerns. Their only worry about being fired is after two consecutive bad performances. The other interesting point is that such an equilibrium exists for a non-zero but not too high transaction cost. If the cost is zero, the manager may engage in some risk management activity in the first period and other states of the second period for the reason previously given. As no action introduces a probability distribution that is less spread-out than the distribution from speculation but more so than the one from hedging, it is quite unlikely that no action would provide the maximum expected payoff to the manager when the cost of hedging and speculation is none. If the cost is too high, the gain from hedging may not be enough to cover the cost.

Contrary to the other equilibria discussed previously, the correlation between managerial risk management activities and tenure in this equilibrium is positive. This phenomenon occurs when the initial reputation of the manager is very high and there is some moderate cost of doing risk management.

3.4 Varying other parameters

In the analysis so far, the reputation of the alternative manager and the coefficient of managerial payment are fixed. Panels (a) and (b) of Figure 4 show how changes of the reputation of the alternative manager affect the equilibria in Result 1 and Result 2. This reputation, ξ ,

determines when the raider takes over the firm. The higher ξ is, the more likely the raider is to make a takeover attempt. Hence, it is not surprising to see that the equilibria in Result 1 exist in a region with higher initial managerial reputation when the reputation of the alternative manager is higher. Higher initial reputation generates higher posterior probability, and this offsets the higher takeover hurdle to keep the behavior of the raider the same. The effect ξ on the equilibria in Result 2, Equilibria III and IV, is similar. In general there is a shift toward high initial reputation when the reputation of the alternative manager is higher.

Panels (c) and (d) of Figure 4 shows the effects of changing the payment coefficient γ on the equilibria in Results 1 and 2. The payment coefficient, γ , can be considered as the marginal amount that shareholders pay a good manager over a bad manager or the wage difference between a good manager and a bad manager in a competitive managerial labor market. When the coefficient γ is increased (Figure 3 Panel (d)), the wage difference is higher and the manager gains more for an increase of reputation. In addition, the opportunity cost to the manager when the firm is taken over rises with γ , too. Hence the benefit of doing risk management is higher, and the region for these equilibria when both types engage in hedging activities in the second period increases. The equilibria where managers take some actions in both periods exist at some cost levels that would not support such equilibria if the coefficient γ had been lower. In this sense, an increase of payment coefficient is equivalent to a decrease of risk management cost. The determinant of whether to take some activities is the ratio of cost and benefit. For the same reason, the equilibrium where both types take no action in the second period exist at a higher cost when γ is larger. On the other hand, if the payment coefficient is smaller, all the equilibria occur at lower cost levels as shown in Figure 3, Panel (c).

Figure 5 shows the effect of varying the reputation of the alternative manager and the compensation coefficient on Equilibrium V, where both types of managers take no action early on and only hedge after an initial bad realization. In general, high reputation of the alternation manager increase the region that supports this equilibrium, so does high payment coefficient. Both effects are driven by the same intuition. High reputation of the alternative manager and

high payoff coefficient both increase the expected cost of the manager when the raider takes over the firm after two consecutive bad draws. In the case of high reputation of the alternative manager, a large set of initial reputation will result in a takeover after two bad draws. Thus the probability of getting takeover is higher. In the case of high payment coefficient, the opportunity cost of takeover is high. Both effects motivate the manager to adopt hedging strategy in a large area of initial reputation and cost combinations.

4 Discussion

As shown in Result 1 and Result 2, for a wide range of parameters, there exist equilibria where the managers speculate or hedge in the first period but not in the second period. In other words, scenarios have been shown in which managers engage in some activities early in their careers. The first reason is that the takeover threat is higher early on because the ability of the manager is unknown and a bad realization can be a signal of low ability. The other reason is that the loss from being taken over is higher early on simply because the new manager has more to lose if he or she is considered a “bad” type early in his or her career. These two reasons together create strong incentives for managers, both good and bad, to hedge or speculate early in their careers to manipulate the signals they are sending. Those managers that survive the takeover in the first period have higher reputations and thus are less concerned about the takeover threat. The loss from being taken over in the second period is also smaller. In general, the incentive for speculation disappear for older managers who have built their reputations.

Corporate takeover is a way to weed out the bad managers from the existing pool of managers. Other managerial disciplinary mechanisms, such as the board of directors firing underperforming managers, serve the same purpose. The essence is that these disciplinary mechanisms put a higher cost on new managers than on old managers. Hence new managers are willing to do more, in this case engage in hedging or speculation activities, to avoid this type of disciplinary action. The managerial labor market also causes new managers to be more

concerned about their reputations since reputations not only affect current wages but also future wages. Overall, building an early reputation and avoiding managerial discipline are the main driving forces causing managers to hedge or speculate early in their careers.

The equilibrium in Result 3 is also interesting as it produces an opposite time series pattern of risk management versus managerial tenure. The intuition is that the manager starts with a really high reputation and knows that he or she can continue to the second period with certainty. The only time that the manager faces takeover is when the firm produces two consecutive negative outcomes. To avoid this, the manager, good or bad, can either hedge in the first period to reduce the probability of having lowest cash flow at time 1, or hedge in the second period if the first outcome turns out to be low. The latter strategy is more cost effective as the manager bears the hedging cost only when Y_1 is 0, the probability of which is quite low. Hence, given that there is a cost of risk management and the initial reputation of the manager is very high, there is an equilibrium that both types of managers hedge in the second period if the first period cash flow is low and take no action in all other cases.

The transaction cost of risk management plays an important role in this analysis. If there is no such transaction cost, the managers almost always choose active strategies of either hedging or speculation. This is not surprising as the strategy of no action induces a distribution that is less centered than the distribution from hedging and less spread-out than the one from speculation. Without considering transaction cost, this passive strategy of no action is not likely to be the optimal strategy. Only when there is some cost in doing risk management, do equilibria where managers may take no action emerge. In practice, cost is a serious concern in making risk management decisions. Empirically, the one firm characteristic with the strongest effect on risk management activities that has been documented so far is firm size, which suggests an economy of scale effect on the risk management operation. Therefore, cost deserves appropriate attention in explaining corporate risk management activities.

Our model provides a number of interesting predictions between managerial career concerns and risk management activities. The first one is that managers with moderate career

concerns tend to do hedging early in their careers and this is confirmed by Tufano (1996). In addition, we also show that there is also a cross sectional effect of this pattern. This pattern should be most pronounced in firms with medium cost of doing risk management. Managers in firms with very low cost may be engaging in risk management all the time, while managers in firms with very high cost may never hedge. If firm size is a proxy for the cost of risk management, then we may most likely find this relation between risk management activities and CEO tenure in mid-sized firms.

The behavior of managers with high career concerns and minimal career concerns is different. We show that managers with high career concerns may speculate early in their careers but may choose to hedge or take no action later in their careers. If speculation is against the interests of shareholders, it is important to identify situations where managers may have the incentive to speculate. Then corporate board can either increase monitoring effort or design other mechanism to reduce the manager's speculative incentive. We also show that "superstar" managers may not hedge or speculate right after they become top managers. However, these "superstar" managers may start hedging after an early bad performance.

Additional empirical predictions come from our results by varying the reputation of the alternative manager and the compensation coefficient. The reputation of the alternative manager can be considered as an indication of the competition of the managerial labor market. In an industry with relatively low managerial special knowhow, it will be easy to bring in an outsider to do a reasonable job. In our model, such industry has high reputation of the alternative manager, and we predict that managers in such industry may engage in either hedging or speculation more than managers in industry where the managerial knowhow is high. The compensation coefficient can be related to managerial compensation directly. Hence our model predicts that managers who are highly compensated may be more likely to take actions than these who are not.

Finally, in this model, we have avoided operational details on how to manage risk and which financial contracts to use for the desired risk profile. However, the distributions from

hedging and speculation in the analysis can be achieved through trading in futures/forwards contracts. The other financial contracts widely available are options. It is important to recognize that neither trading futures nor trading options should change the mean of firm cash flow. The change happens to the variance, skewness, and kurtosis of the cash flow; in other words, the second and higher moments of the cash flow distribution are changed by risk management. Futures cause the distribution to contract or expand symmetrically across the center of the distribution while options skew the distribution toward one tail. However, the basic idea of this model would not change if options were explicitly allowed in the strategy space of the manager. The incentive for managing risk is generally higher in the early stage of a manager's tenure than it is when the manager has been in office for some time. With some transaction costs, managers may hedge or speculate more early in their tenures than they do late in their tenures.

5 Conclusion

In this paper, risk management is modeled as a private action of the manager to change the probability distribution of firm cash flows. Both hedge and speculation are allowed as possible risk management strategies. In a dynamic model, managers have incentives to engage in risk management activities in order to manipulate the signals they send to the public. Furthermore, for a wide range of parameter values, there exist equilibria where managers hedge or speculate early in their tenures and take no action late in their tenures. The intuition for this time series pattern of risk management behavior is that managers generally benefit more by being active early and the loss from not taking actions is also higher early in their tenures. Both contribute to a higher incentive to hedge or speculate early.

When the manager has a really high initial reputation, he or she may defer the decision of risk management to a later period so that the manager only needs to hedge if he or she is unlucky and receives a bad draw early in the career. The insight is that the high initial

reputation shields the manager from corporate discipline if he or she produces just one bad signal. Hence, the manager can defer the risk management decision after the early information is released, and only needs to hedge when the early information is unfavorable to him or her. This risk management strategy is more cost effective than doing risk management at the beginning of managerial tenure.

The motivation for risk management and the practice of risk management are still not clear to financial economists. In the paper, we provide one more rationale for corporate risk management from a managerial self interest point of view. We also provide an explanation for Tufano's (1996) empirical finding, that the correlation between risk management activities and managerial tenure is negative. Transaction costs of risk management has been shown to play an important role in corporate decision making, a fact which has been largely overlooked in the current literature of risk management.

Other questions that can be addressed include the issue of microhedge versus macrohedge and the design of an optimal managerial compensation mechanism when managers have access to the financial markets for managing risks. While academics unanimously favor macrohedge or firm level risk management, the accounting rules tend to favor microhedge or transaction level hedge. How the current accounting rules affect corporate risk management and risk control is an important question to be investigated and is closely related to the managerial compensation issue. It is also important for shareholders and boards of directors to evaluate the effect of risk management opportunities on current managerial compensation and to design optimal mechanisms to benefit from corporate risk management activities.

6 References

- Agrawal, A. and Walkling, R.A. (1994). Executive careers and compensation surrounding takeover bids. *Journal of Finance*, 49, 985-1014.
- Allayannis, George, and Ofek, Eli (2001). Exchange rate exposure, hedging, and the use of foreign currency derivatives. *Journal of International Money and Finance* 20(2), 273-296.
- Berkman, Henk, and Bradbury, Michael E. (1996). Empirical evidence on the corporate use of derivatives. *Financial Management* 25(2) 5-13.
- Breeden D. and Viswanathan, S. (1998). Why do firms hedge? An asymmetric information model. Working paper, Duke University.
- DeMarzo, P.M. and Duffie, D. (1991). Corporate financial hedging with proprietary information. *Journal of Economic Theory*, 53, 261-286.
- DeMarzo, P.M. and Duffie, D. (1995). Corporate incentives for hedging and hedging accounting. *Review of Financial Studies*, 8, 743-771.
- Dolde, W. (1995). Hedging, leverage, and primitive risk. *Journal of Financial Engineering*, 4, 187-216.
- Froot, K.A., Scharfstein, D.S., and Stein, J.C. (1993). Risk management: coordinating corporate investment and financing policies. *Journal of Finance*, 48, 1629-1658.
- Fudenberg, D. and Tirole, J. (1991). Perfect Bayesian equilibrium and sequential equilibrium. *Journal of Economic Theory*, 53, 236-260.
- Gay, Gerald D., Nam, Jouahn, 1998. The underinvestment problem and corporate derivatives use. *Financial Management*, 27(4), 53-69.
- Geczy, C., Minton, B.A., and Schrand, C. (1997). Why firms use derivatives: distinguishing among existing theories. *Journal of Finance* 52(4), 1323-1354.

- Holmstrom, B. and Ricart I Costa, J. (1986) Managerial issues and capital management. *Quarterly Journal of Economics*, 101, 835-860.
- Howton, Shawn D., and Perfect, Steven B. (1998). Currency and interest-rate derivatives use in US firms. *Financial Management* 27(4), 111-121.
- Knopf, John D., Nam, Jouahn, and Thornton, John H., (2002) The volatility and price sensitivities of managerial stock option portfolios and corporate hedging. *Journal of Finance*, 57, 801-813.
- Mayers, David, and Smith, Clifford W., Jr., 1982. On the corporate demand for insurance. *Journal of Business*, 55(2), 281-296.
- Mian, S.L. (1996). Evidence on corporate hedging policy. *Journal of Financial and Quantitative Analysis*, 31, 419-439.
- Milgrom, P.R. (1981). Good news and bad news: Representation theorems and applications. *Bell Journal of Economics*, 12, 380-391.
- Modigliani, F. and Miller, M. (1958). The cost of capital, corporation finance and the theory of investment. *American Economic Review*, 53, 261-297.
- Nance, D.R., Smith, C.W. Jr., and Smithson, C.W. (1993). On the determinants of corporate hedging. *Journal of Finance*, 48, 267-284.
- Smith, C.W. Jr., and Stulz, R.M. (1985). The determinants of firms' hedging policies. *Journal of Financial and Quantitative Analysis*, 20, 391-405.
- Tufano, P. (1996). Who manages risk? An empirical examination of risk management practices in the gold mining industry. *Journal of Finance*, 51, 1097-1138.
- Wall, Larry D., and Pringle, John J., (1988) Interest rate swaps: A review of the issues. *Federal Reserve Bank of Atlanta Economic Review* 73(6) 22-40.

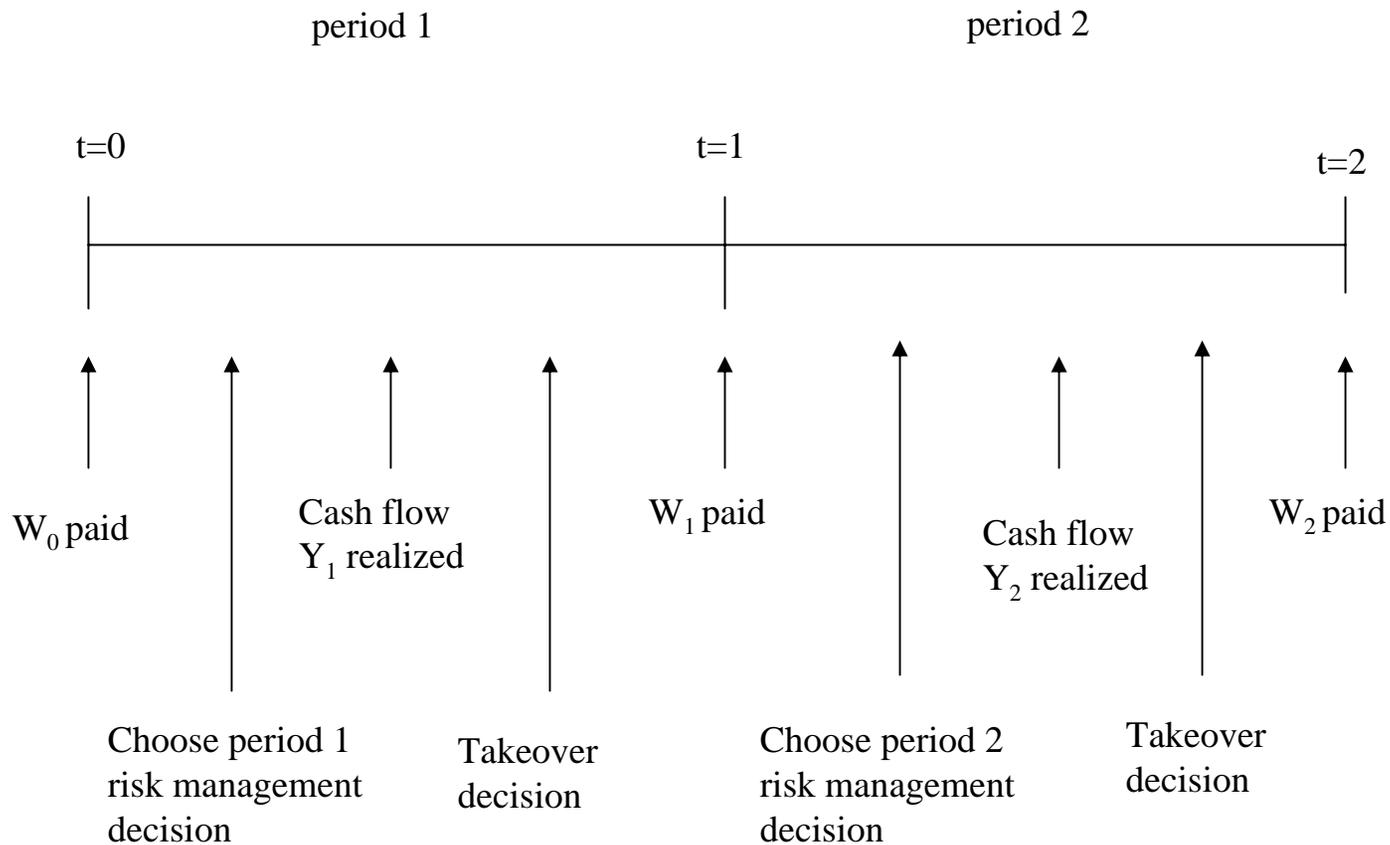


Figure 1. Time line of the game.

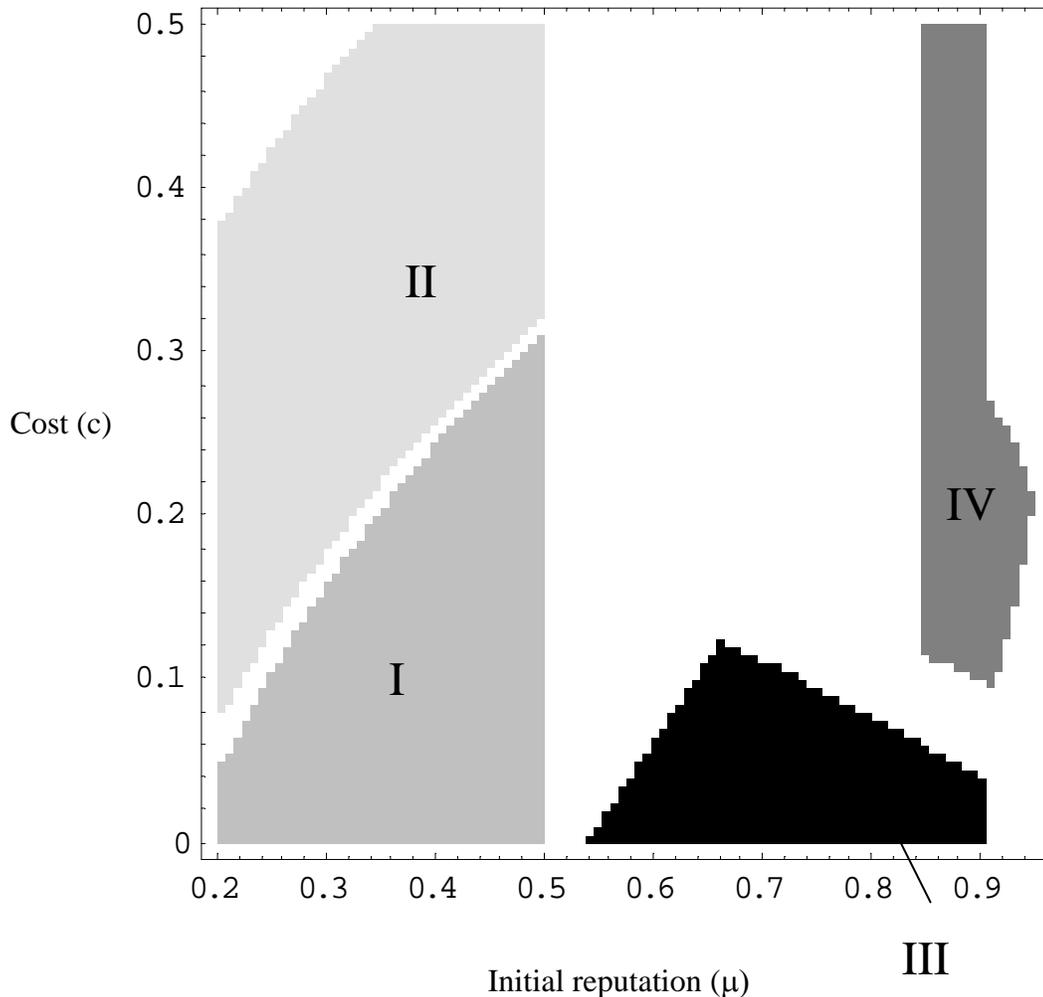


Figure 2. Equilibria when initial managerial reputation μ is between 0.2 and 0.95. In equilibrium I, both managers speculate in the first period and hedges in the second period when Y_1 is 2. In equilibrium II, both managers speculate in the first period and do not take risk management action in the second period when Y_1 is 2. In equilibrium III, both managers hedge in the first period and hedges in the second period when Y_1 is 1 or 2. In equilibrium IV, both managers hedge in the first period and do not take risk management action in the second period when Y_1 is 0 or 2. Other parameters used are: $\alpha=0.55$, $\beta=0.35$, $\delta=0.05$, $\xi=0.5$, $\gamma=10$.

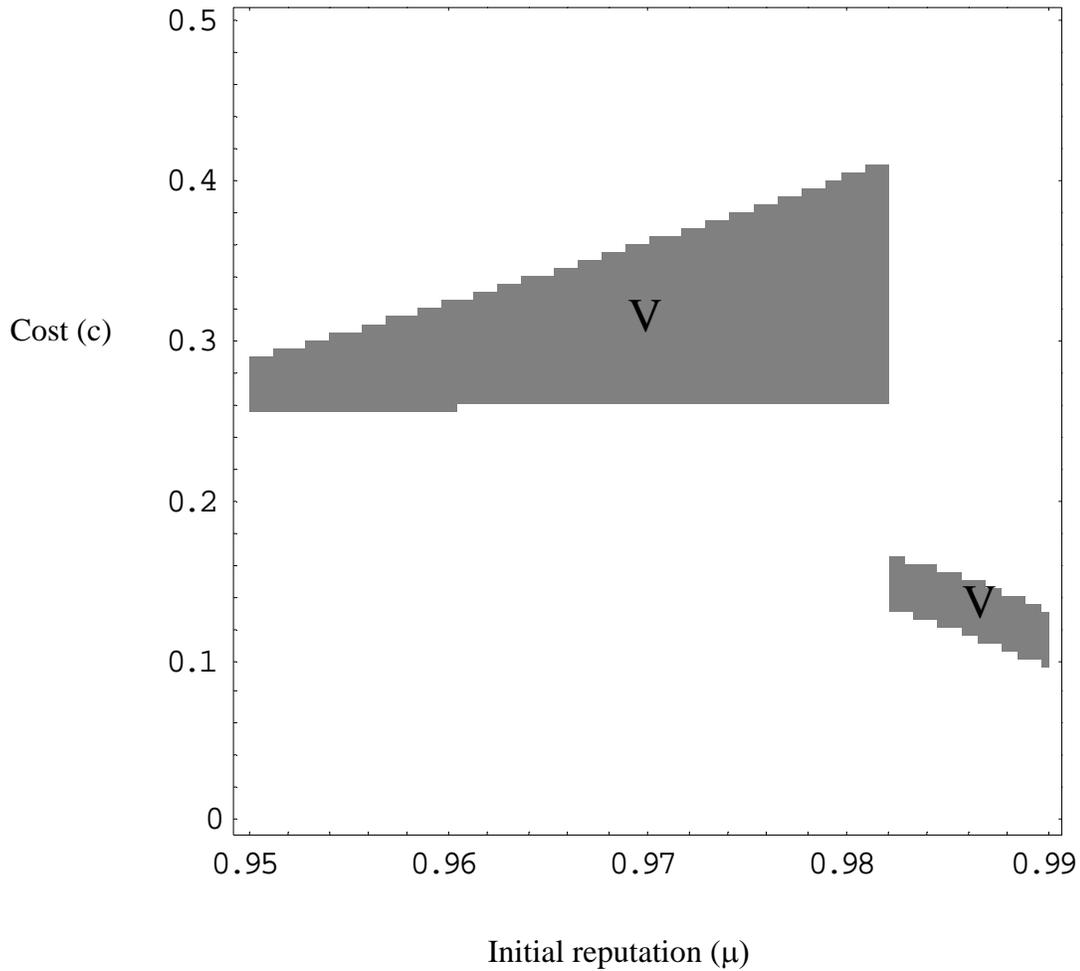


Figure 3. Equilibria when initial managerial reputation μ is extremely high (between 0.95 and 0.95). In equilibrium V, both managers take no risk management action in the first period and in the second period if Y_1 is 1 or 2, and hedge in the second period only when Y_1 is 0. The parameters used are: $\alpha=0.55$, $\beta=0.35$, $\delta=0.05$, $\xi=0.5$, $\gamma=10$.

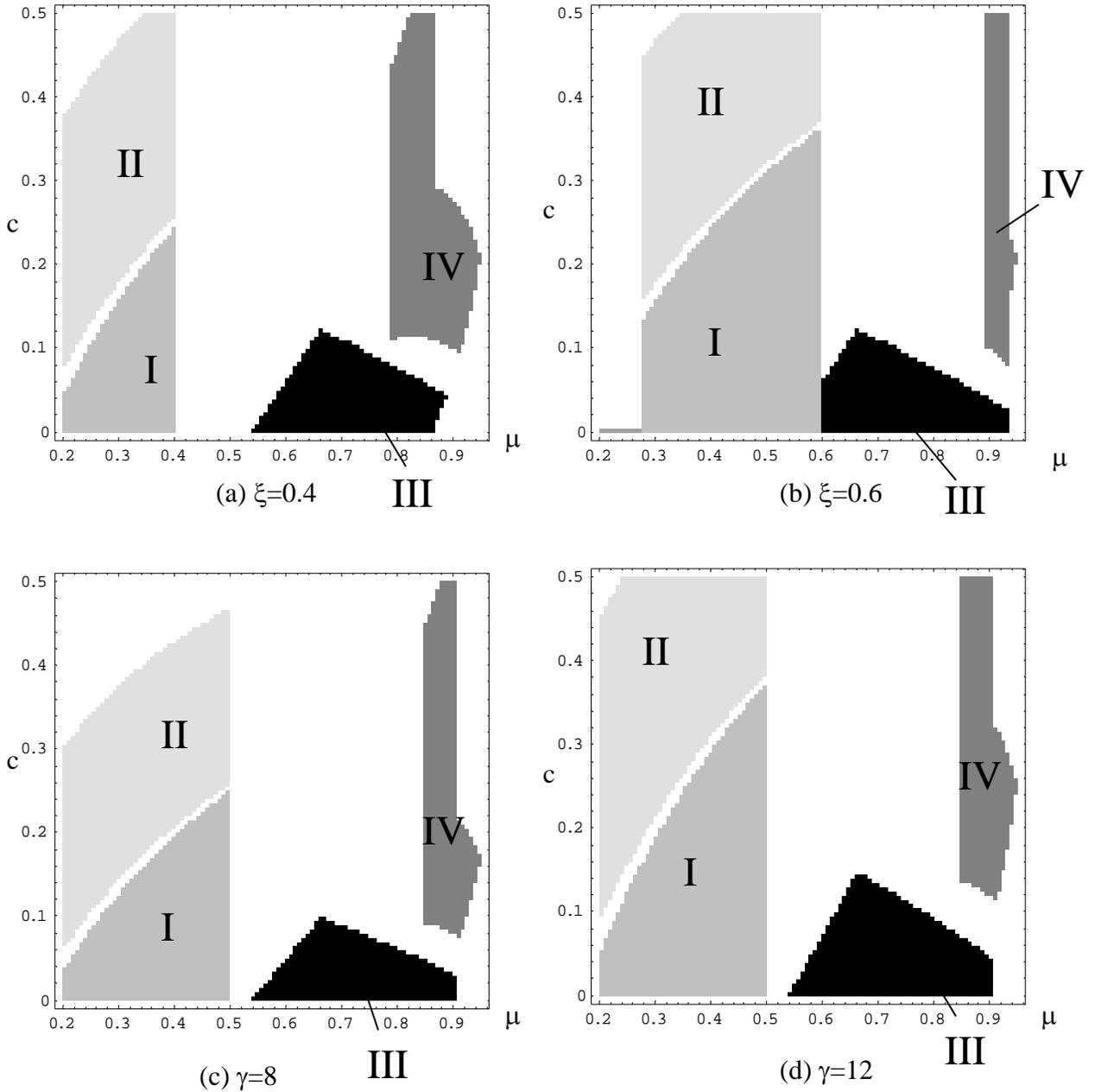
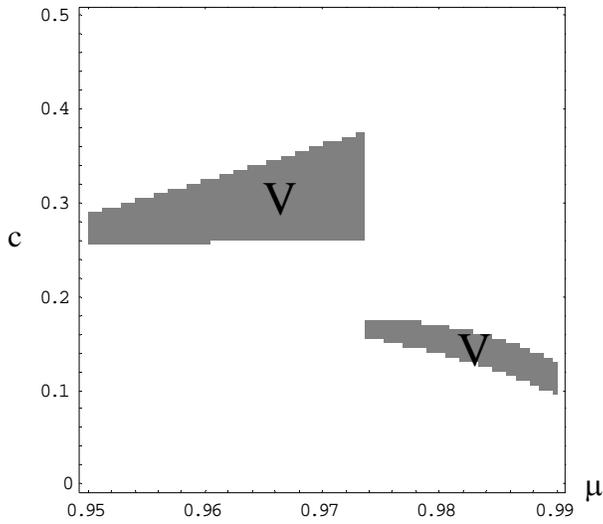
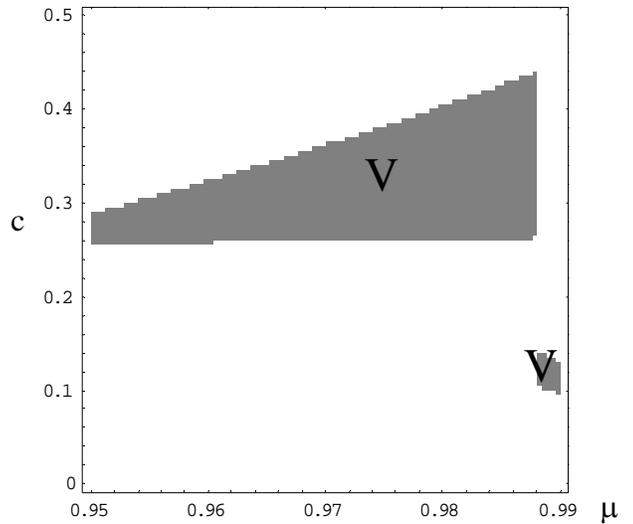


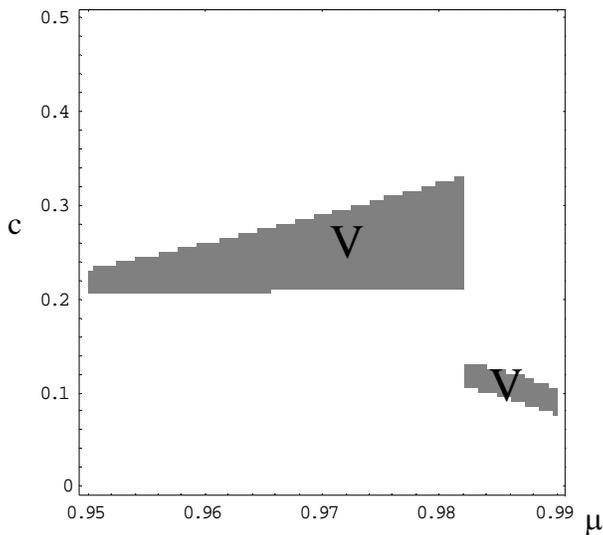
Figure 4. Equilibria when initial managerial reputation μ is between 0.2 and 0.95 under alternative conditions. In equilibrium I, both managers speculate in the first period and hedges in the second period when Y_1 is 2. In equilibrium II, both managers speculate in the first period and do not take risk management action in the second period when Y_1 is 2. In equilibrium III, both managers hedge in the first period and hedges in the second period when Y_1 is 1 or 2. In equilibrium IV, both managers hedge in the first period and do not take risk management action in the second period when Y_1 is 0 or 2. The base set of parameters used are: $\alpha=0.55$, $\beta=0.35$, $\delta=0.05$, $\xi=0.5$, $\gamma=10$. Each panel has one parameter change from the base set.



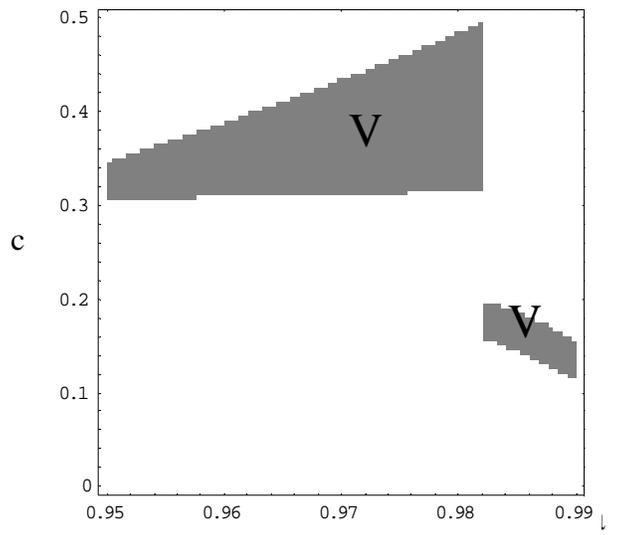
(a) $\xi=0.4$



(b) $\xi=0.6$



(c) $\gamma=8$



(d) $\gamma=12$

Figure 5. Equilibria when initial managerial reputation μ is extremely high (between 0.95 and 0.95) under alternative conditions. In equilibrium V, both managers take no risk management action in the first period and in the second period if Y_1 is 1 or 2, and hedge in the second period only when Y_1 is 0. The base set of parameters used are: $\alpha=0.55$, $\beta=0.35$, $\delta=0.05$, $\xi=0.5$, $\gamma=10$. Each panel has one parameter change from the base set.